CHAPTER 3
Affected Environment

INTRODUCTION

The "Affected Environment" chapter describes existing conditions for those elements of the natural environment that would be affected by the implementation of the actions considered in this *Shoreline Restoration and Management Plan / Draft Environmental Impact Statement* (EIS). The natural environment components addressed include coastal processes, aquatic fauna, terrestrial habitat, threatened and endangered species and species of concern, and wetlands and pannes. Soundscapes, visitor experience, and park operations are also addressed. Impacts for each of these topics are analyzed in the "Environmental Consequences" chapter.

INDIANA DUNES NATIONAL LAKESHORE BACKGROUND

Lake Michigan Geological Setting

Southern Lake Michigan lies within the western half of the Michigan basin, a geologic depression formed as a result of tectonic activity. Since the last glacial retreat began approximately 12,000 years ago, the southern Lake Michigan shoreline has been shaped by the forces of a dynamic environment, including lake level fluctuations, shoreline erosion, and sediment deposition. This glacial retreat, re-advance, and retreat from early Lake Michigan (paleo-Lake Chicago), referred to as the Wisconsin Glacial Episode of the Pleistocene Epoch (Pielou 1991), is responsible for many of today's geologic formations at Indiana Dunes National Lakeshore (Foster and Folger 1994). The geographical features, as such, were created through the interaction of lake recession, Lake Michigan surface winds, and erosion over time.

HYDROGEOLOGIC SETTING

The relationship between groundwater and surface water in the Great Lakes region is one that, while important, is not well understood. In most instances, the natural flow of a stream includes both a surface water runoff component and a groundwater inflow component. The groundwater component comprises most of the drainage into Lake Michigan; it is estimated that approximately 80% of the total annual flow of tributary streams to Lake Michigan originate as groundwater. This water tends to be nearly constant in temperature despite seasonal weather changes, and is therefore vital to ecosystem functions within Lake Michigan and its tributaries (Grannemann 2004). As the groundwater entering Lake Michigan is often a non-point source for contamination (e.g., stormwater runoff), anticipating and effectively managing potentially detrimental water quality issues is unlikely and often outside the capabilities of park staff at Indiana Dunes National Lakeshore.

CLIMATE CHANGE

As previously discussed in the "Purpose and Need for Action" chapter, recent climate change trends in the Indiana Dunes National Lakeshore vicinity include:

- an increase in annual temperatures of 0.25°C per decade
- a progressive advance in the date of the last spring freeze
- increases in autumn precipitation
- doubling of frequencies of heavy rainfall events and an increase in the number of individual rainy days and week-long heavy rainfall events
- increased flooding

- an increase in the number of heat waves and record-high temperatures (Hayhoe *et al.* 2010)

Climate change may have an effect on Lake Michigan coastal processes in the future, though specific effects in the park are difficult to predict. As summer temperatures continue to rise, evaporation has begun to greatly contribute to lake level changes for the first time (since 1980). Scientists believe that the level of Lake Michigan may continue to decrease because of this (USGCRP 1996). Additionally, recent studies of the Great Lakes region indicate that ice cover in the center of the lakes shrank by more than 30% between 1970s and 2002. Through 2009, ice cover across the entire surface of the lakes had fallen 15%. It is projected that Lake Michigan may have some winters with no ice cover in as soon as ten years (Rocky Mountain Climate Organization 2011). Decreasing ice cover would increase the impacts of storms on the nearshore, and on the foredune and dune complex. With reduced winter ice and snow cover, the dunes are afforded less protection against sediment blowing away from the dunes and beach, and against wave action undercutting the shoreline, increasing erosion rates. Conversely, greater wave action would also increase the deposition of sediment in some places, thereby increasing accretion areas and the need for maintenance (Rocky Mountain Climate Organization 2011). The combination of exacerbated erosion and deposition rates would alter the Indiana Dunes National Lakeshore beach profile.

In addition, climate change may have an effect on the native fish assemblages and benthic species in the nearshore environment along Indiana Dunes National Lakeshore. Scientists believe that distribution of fish may change according to the temperature of water. Warm water fish populations are projected to expand northward, while cold water fish populations would decrease, or disappear from the Great Lakes altogether. Increasing temperatures and stronger storm events would disrupt the shallow waters where many fish spawn, threatening population levels of native fish (USGCRP 1996). As fish are forced to move to deeper waters, they may be exposed to increased predation as they would lose the protection afforded by shallower waters. Additionally, higher water temperatures also lead to lower oxygen levels, promoting release of contaminants such as phosphorus and mercury, which become more soluble when oxygen levels decrease. When fish absorb these contaminants, they are a health hazard not only for predatory fish and animals, but also humans that consume them (Rocky Mountain Climate Organization 2011).

Warmer waters may also promote the replacement of native fish species by nonnatives able to thrive in varied or disturbed environmental conditions, as native species are often adapted to a narrower range of conditions that can be disrupted by a changed climate. If, for example, the Asian carp (*Hypophthalmichthys* spp.) established in Lake Michigan, this fish would consume massive amounts of plankton, reducing the food available for native fish (Rocky Mountain Climate Organization 2011). Additionally, zebra mussels add to increased productivity in lakes by outcompeting native species and increasing water clarity that leads to accelerated algae growth (USGCRP 1996).

While scientists expect climate change to have an effect on the park's vegetation, the rate and magnitude of potential modifications are not known. It is known, however, that the growing season in the park has been expanding as spring arrives sooner, and the first freeze is occurring later. Increasing variability of temperature and precipitation are harmful to vegetation and cause diebacks. Additionally, increasing levels of carbon dioxide affect the physiology of vegetation, and may increase the productivity of trees (USGCRP 1996).

Within Indiana Dunes National Lakeshore, climate change is likely to increase the threats posed to natural plant communities by nonnative invasive plants, since invasive plants typically thrive in a wider range of

environmental conditions and can out-compete native plants for water, nutrients, and other plant essentials. A warmer climate would promote the spread of even more invasive plants into the park (Rocky Mountain Climate Organization 2011).

COASTAL PROCESSES

SEDIMENT TRANSPORT PROCESSES

Changes in Lake Michigan water levels have occurred since its formation. These fluctuations in levels affect both natural and manufactured resources. Flooding and shoreline erosion result in property damage, impact wetland acreage, and impact depths of navigation channels. Unusually high lake levels in the 1950s, 1970s, and mid-1980s led to numerous investigations to identify the causes of lake level fluctuations, and potential modifications to the lake system to resolve problems associated with the extreme levels (IDNR Division of Water 1994).

In an uninterrupted system, the amount of sediment erosion or deposition that occurs in any given year at a location along the shoreline is affected by such natural factors as physical configuration of the shoreline, wave approach angle, nearshore circulation, availability of sediment, prevailing wind direction, and seasonal differences in storm intensity. In general, seasonal differences in storm intensity result in a yearly cycle of narrow winter beaches and wide summer beaches. High lake levels and severe storms usually result in the highest erosion rates along unprotected portions of a shoreline (IDNR Division of Water 1994).

Two of the greatest changes to the shoreline at Indiana Dunes National Lakeshore are navigation structures and the existence of engineered peninsulas projecting into the lake, each created primarily for industrial expansion. Approximately 4,053 acres of man-made land was created, surveyed, and is now patented in Lake Michigan (IDNR Division of Water 1994). Such human modifications have interacted with natural shoreline processes over the last century, drastically altering the Lake Michigan shoreline profile and resulting in unstable conditions. Manufactured structures disrupt sediment movement along the shoreline and impede additional supplies of sediment from moving into the system. This interrupted sediment movement has resulted in erosion of the shoreline in some locations and accumulation of sediment in others. Examples of both situations exist within reaches 1 through 4 of Indiana Dunes National Lakeshore (IDNR Division of Water 1994).

Due to a high rate of accretion on the updrift side of the Northwest Indiana Public Service Company (NIPSCO)/Bailly industrial complex, various methods have been employed to maintain the associated shipping canals and the water intake. Maintenance dredging has occurred downdrift of the Port of Indiana industrial complex at Burns International Harbor.

To combat the increasing trend of interruptions to littoral drift, the U.S. Army COE has conducted beach nourishment activities at Crescent Dune, near Mount Baldy, annually since 1974. According to a 2006 study, the average annual background erosion rate for the Great Lakes is approximately 1 meter; the beach at the toe of Mount Baldy is eroding at a rate of approximately 3 meters annually (Przybyla-Kelly and Whitman 2006). In the past 26 years, more than 1.2 million cubic yards of material has been placed at Crescent Dune, and has moved downdrift via natural wave action

(COE, Bucaro, pers. comm. 2011a). Studies conducted since 1985 have shown that sediment placed at the eastern end of the park erodes entirely within two to five years (COE 1986; Horvath *et al.* 1999).

DUNE FORMATION PROCESSES

Foredune development occurs when the lake level remains relatively constant and sediment is deposited, trapped, and held onshore by vegetation. When natural geologic conditions exist, the dynamic nature of the Indiana Dunes National Lakeshore shoreline provides many opportunities for habitat succession. Habitat connectivity and natural shoreline processes are vital to the conservation of the foredune and dune complex at the park. Historically, sediment moved naturally from the beach throughout the foredune complex in the project area, thereby providing a key link between terrestrial ecosystems and coastal processes. As Lake Michigan receded over time, foredunes succeeded into mature, stabilized dune forests. A disruption to one part of the link (e.g., eliminating natural sediment supply), affects the ecological integrity and dynamic stability of the entire foredune and dune complex in the project area.

AQUATIC FAUNA

THE NEARSHORE ENVIRONMENT

For the purposes of this plan, the nearshore area is encompassed by water depths generally less than approximately 9 meters (30 feet). It includes both higher-energy coastal margin areas and lower-energy nearshore open-water areas. Nearshore open-water areas are subject to higher wave energies and associated littoral or nearshore processes during large storm events.

Historically, Indiana Dunes National Lakeshore nearshore waters served primarily as habitat for fish, wildlife, and the aquatic organisms that supported their production. A large number of Lake Michigan fish use the nearshore waters for one or more critical life stages or functions. The nearshore waters are areas of temporary feeding or nursery grounds for some species, a year-round residence for other fish, and migratory pathways for anadromous fish (i.e., fish born in fresh water that spend most of their life in the sea and return to fresh water to spawn).

Fish species diversity and production in the nearshore waters are higher than those in offshore waters and are generally highest in the shallower, more enriched embayments with large tributary systems (Edsall and Charlton 1997). Alterations to river mouths and modifications to the shoreline at Indiana Dunes National Lakeshore have interrupted flow paths and disrupted nearshore coastal processes that create and maintain nearshore habitats. Many native species require relatively shallow, well-oxygenated waters flowing though coarse gravel and cobble substrates with protected interstitial spaces. Spawning areas are often adjacent to nearshore nursery areas, and rely on regional circulation patterns to transport larval fish into adjacent nursery areas.

The nearshore waters are not only habitat for fish, but also for many other species. Nearshore waters are critical feeding and resting habitat for waterfowl such as ducks, geese, and swans, especially during the fall and spring migrations. Aquatic mammals, including muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), otter (*Lontra canadensis*), and mink (*Mustela vison*) can be found in some undisturbed, sheltered waters in the lower reaches of tributaries and near coastal wetlands. Great Lakes nearshore waters are critical habitat for threatened or endangered species and species of special concern, including the piping plover (*Charadrius melodus*), bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and freshwater mussels.

NATIVE SPECIES

The southern shoreline of Lake Michigan, specifically along Indiana Dunes National Lakeshore, offers a rare environment within the Midwest region of the country. The sandy substrate of the lakeshore provides for benthic species and fish assemblages intertwined in a delicate food web that is easily disrupted by external forces that include water quality concerns from surrounding industrial discharges, unequal distribution of sediment supply, and the introduction of nonnative species.

MUSKRAT

Meiofauna and Macroinvertebrates

In large oligotrophic lakes like Lake Michigan, abundance of the dominant groups of benthic organisms tends to be directly proportional to the amount of available food; increased amounts of phytoplankton lead to increased amounts of organic material settling to the lake bottom, thereby providing more potential food for macrobenthos (Madenjian *et al.* 2002). In the relatively high wave energy nearshore environment, at certain sediment-starved areas along the shoreline (particularly at the base of Mount Baldy), the clay substrate naturally found beneath the sediment has been exposed, and organic matter often found in calmer waters has been carried away from the shoreline. The kinetic nature of the nearshore environment, coupled with sediment deprivation from anthropogenic influences, has resulted in low-density and diversity within the benthic communities in the project area. One study, conducted from 1996 to 1998 in conjunction with a COE beach nourishment program, showed that relatively few species were detected in the benthic communities inhabiting sandy substrates in the nearshore area (Horvath *et al.* 1999). Benthic species such as roundworm (phylum *Nematoda*), aquatic worm (subclass *Oligochaeta*), seed shrimp (subclass *Ostracoda*), bloodworm (family *Chironomidae*), and copepods (*Calanus hyperboreus*) are among the most common invertebrates identified in the sandy substrates in the project area. Two main invertebrate groups, nematoda and oligochaeta, appear to be most abundant (Przybryla-Kelly and Whitman 2006). Generally, the meiobenthos outnumber the macrobenthos in the nearshore environment (Last *et al.* 1995). A summary of benthic species in the Lake Michigan nearshore is provided in Appendix D: Species List.

A 2004 study of the benthic invertebrate community of southern Lake Michigan was conducted to evaluate the effects of beach nourishment on the nearshore environment (Garza and Whitman 2004). As many of the benthic taxa identified in the Lake Michigan nearshore are part of the detrital food web (National Oceanic and Atmospheric Administration / Great Lakes Environmental Research Laboratory 2009), the increased stability afforded by deeper water may sustain a larger benthic community by allowing for a greater accumulation of organic matter (Garza and Whitman 2004). The study did reveal a notable decrease in mean invertebrate density downdrift from the site of beach nourishment, suggesting that sediment placement affected invertebrate populations. A subsequent study conducted in 2006, however, indicated that the benthos within the nearshore experienced a relatively high rate of recovery within 8 to 12 months after nourishment activities. The densities and total number of benthic taxa increased with depth, suggesting a lower impact of sediment drift and wave action in deeper waters (Przybryla-Kelly and Whitman 2006).

Fish of Lake Michigan

The Indiana Dunes National Lakeshore nearshore waters are key areas for nutrient exchange, and serve as important spawning and nursery habitat for one or more life stages of most Lake Michigan fish. The hard clay outcroppings along the shoreline at the base of Mount Baldy and the cobble/gravel areas in reach 2, are two examples of habitat ideal for fish spawning and nurseries, particularly for yellow perch (*Perca flavescens*). The nearshore area also provides such habitats for smallmouth bass (*Micropterus dolomieu*) and other important fish. Coastal wetland habitats support spawning and early life stages of bass, sunfish, northern pike (*Esox lucius*), walleye(*Sander vitreus*), and yellow perch. Thus, natural and anthropogenic threats (e.g., armoring of shorelines, contamination of water) that degrade or alter any of these habitats severely affect fish-community diversity and relative abundance (Rutherford 2008).

Nearshore fish include recreationally and commercially important species such as yellow perch, walleye, smallmouth bass,

northern pike, catfish, and sunfish, as well as nongame species, including spottail shiner (*Notropis hudsonius*), slimy sculpin (*Cottus cognatus*), mottled sculpin (*Cottus bairdii*), trout perch (*Percopsis omiscomaycus*), and johnny darter (*Etheostoma nigrum*) (Clapp *et al.* 2005).

The yellow perch is a spiny-rayed fish that experiences a diet shift during its life cycle. As young and larval fish, yellow perch feed on microscopic organisms such as zooplankton, but with increasing size, macroinvertebrates (such as midges) comprise a larger portion of their diet. As adults, yellow perch diets include invertebrates, fish eggs, mysid shrimp (*Americamysis bahia*), and other fish such as minnows. Yellow perch are predominantly piscivorous, known in some cases to eat other members of the perch family (Hubbs and Lagler 1964; Bergman and Greenberg 1994). A decline in yellow perch populations in southern Lake Michigan was observed in the 1990s. Declines in prey beginning in the 1980s were noted in conjunction with the introduction of nonnative species such as the zebra mussel, round goby (*Neogobius melanostomus*), and alewife (*Alosa pseudoharengus*).

A summary of fish assemblages historically found in the Lake Michigan nearshore is provided in Appendix D: Species Lists.

INVASIVE AND NONNATIVE SPECIES

Background

Nearshore and coastal waters have provided habitat for the 184 nonnative species introduced to the Great Lakes since 1840. These habitats have been profoundly altered by nonnative species, with effects ranging from uprooting of wetland plants by common carp, to the creation of microhabitats by dreissenid mussels. The status of the Great Lakes nearshore waters with respect to nonnative and invasive species is poor. Since 1996, 18 new nonnative species have been discovered; a rate of 1.5 per year. This rate is higher than the long-term discovery rate (1.1 per year since 1840), though lower than the rate since the opening of the St. Lawrence Seaway in 1959 (1.8 per year). Despite a slightly lower discovery rate in the last 15 years, an increase in the number of nonnative species in the Great Lakes represents a deteriorating trend as additional nonnative and invasive species indicate further disruption of existing food webs, often in unpredictable and/or undesirable ways (Holeck *et al.* 2009).

Deteriorating conditions in the shallow water near the coastal zone is a fairly common theme in Lake Michigan. In general, for the last several decades offshore conditions have been improving, whereas nearshore conditions have worsened and/or failed to show sustained improvement (Mason 2009). Key invasive species identified in the Indiana Dunes National Lakeshore project area are discussed below.

Zebra and Quagga (*Dreissenid*) Mussels

Zebra mussels were first documented in Lake Michigan in 1989 and rapidly increased in nearshore rocky habitats. Quagga mussels were first documented in Lake Ontario, and were identified in Lake Michigan by 1997 (Detmers *et al.* 2008). Quagga mussels have greatly expanded their range in Lake Michigan since the early 2000s, and have replaced zebra mussels in many areas (Pothoven *et al.* 2009). Both zebra mussels and quagga mussels are natives of the Ponto-Caspian region, and are thought to have invaded the Great Lakes via ballast water.

Zebra mussels have the ability to filter water, allowing sunlight to penetrate to greater depths, potentially resulting in additional growth of algae blooms. These dreissenid mussels also may be partially responsible for the lack of improvement in nearshore water quality despite distinct improvements in offshore waters from the decline in phosphorus loadings. Some researchers

suggest that dreissenids sequester phosphorus in nearshore areas through their filtering activity and through deposition of mucus covered pseudofeces (Holeck *et al.* 2009).

Dreissenid mussels compete directly with zooplankton for food because they filter phytoplankton from the water column. Since dreissenid mussels invaded Lake Michigan, zooplankton densities, when first-feeding of yellow perch larvae occurs, have declined, indirectly resulting in reduced numbers of age-0 yellow perch in the fall. It has been hypothesized that the recent decline in Diporeia (*Diporeia* spp.) populations in southern Lake Michigan is another apparent indirect effect of dreissenid mussels. This decline is relevant to the health of nearshore fish as Diporeia is an energy-rich food source and an important prey for several fish, including alewife, yellow perch, and slimy sculpin (Detmers *et al.* 2008).

Round Goby

The round goby is indigenous to the Black, Azov, and Caspian Seas (Kuhns and Berg 1999). This invader was first reported in Lake Michigan in 1993 and is an aggressive species that feeds on lake-bottom or benthic fish.

It has been suggested that round gobies have exerted both positive and negative impacts on the nearshore fish community. Despite a nearshore environment exhibiting a change in species composition as a result of invasive species, fish such as the yellow perch have been able to adapt their diet and respond positively by making round gobies a new food source for adult yellow perch (Truemper *et al.* 2006). Conversely, negative impacts from consumption of round gobies are also likely. Round gobies greater than 50 millimeters in length consume dreissenid mussels, and because of this, biomagnification of toxic substances (e.g., polychlorinated biphenyls and polychlorinated naphthalene) through the food web is likely. Additionally, round gobies have essentially eliminated important nearshore fish, including the mottled sculpin and johnny darter (Truemper *et al.* 2006; Detmers *et al.* 2008).

Potential Future Invasive and Nonnative Species in Lake Michigan

Other potential invaders may arrive during the next few years because of the high rate of commercial, industrial, and recreational use of Lake Michigan, particularly in areas adjacent to Indiana Dunes National Lakeshore. Of special concern is the possibility that silver carp (*Hypophthalmichthys molitrix*) and/or bighead carp (*Hypophthalmichthys nobilis*), collectively known as Asian carp, would enter Lake Michigan through the Chicago Sanitary and Ship Canal (CSSC), the live food trade, or other means. Three electric dispersal barriers were constructed by the COE in the CSSC to deter the interbasin transfer of invasive nonnative fish species between the Mississippi River and the Great Lakes basins. The barriers are formed of steel electrodes secured to the bottom of the CSSC, creating an electric field in the water to discourage fish from crossing (COE 2011b). Similarly, efforts among U.S. and Canadian agencies and legislative bodies are seeking to eliminate trade of live Asian carp (Detmers *et al.* 2008).

The northern snakehead (*Channa argus*) is another potential invader. This species escaped into the Potomac River basin, most likely from aquarium releases. Specimens have been collected by the Wisconsin Department of Natural Resources and the Michigan Department of Natural Resources from the non-Great Lakes waters of these states. One snakehead was collected by an angler while fishing in a Chicago harbor in October 2004. Based on an intensive sampling effort in the harbor, best estimates suggest that this snakehead was released from an aquarium and is not part of an established population. However, additional monitoring of Chicago harbors would continue to provide critical early warning signs. Other fish that would rise to pest status if they do establish in the Great Lakes include tyulka (*Clupeonella cultriventris*), Eurasian minnow (*Phoxinus*

phoxinus), Black sea silverside (*Atherina* spp.), European perch (*Perca fluviatilis*), and monkey goby (*Neogobius fluviatilis*) (Detmers *et al*. 2008).

TERRESTRIAL HABITAT

The park is within the Indiana natural region categorized as the Lake Michigan Natural Region and the Northwestern Morainal Natural Region (see Map 3-1). As shown on Map 3-1, the Lake Michigan Natural Region is entirely aquatic, comprised solely of Lake Michigan (Homoya 1985). The terrestrial portion of the project area is situated within the Northwestern Morainal Natural Region; specifically, within the Lake Michigan Border section and the Chicago Lake Plain section of this natural region.

The Lake Michigan Border section represents a narrow band immediately adjacent to Lake Michigan. It is the youngest of the morainal complexes in Northwest Indiana, representing a discontinuous dune ridge (Greenberg 2002). Beach, foredune, high dunes, and pannes are the most common natural communities within this section, with sand as the most common substrate (calcareous sand in pannes) and muck in interdunal depressions. The Chicago Lake Plain section is located farther from the lake, south and southeast of the Lake Michigan Border section, and is characterized by ridge-and-swale and lacustrine plain topography on mostly acidic sand substrates. The natural communities found most commonly in the Chicago Lake Plain section include marsh, lake, sand savanna, sand prairie, and swamp, while forests make up a less common portion of this section (Homoya 1985).

The onshore boundary of the project area encompasses portions of the dune complex and the entirety of the foredune complex within the authorized boundary of the park. The latter constitutes three distinct community types: beach, foredune, and blowout (Wilhelm 1990).

NATIVE PLANT COMMUNITIES

The park contains a great diversity of plant communities and plant species because of the influence of, and proximity to, Lake Michigan and the intersection of the prairie, boreal, and deciduous forest biomes. Littoral drift and sediment deposition have created beach ridges of various complexities, which have resulted in a concentration and juxtaposition of a wide range of natural communities (Greenberg 2002). Many plant species in the park are of conservation concern as they are located at the edge of their geographical ranges.

BEACH PEA

Foredune Complex

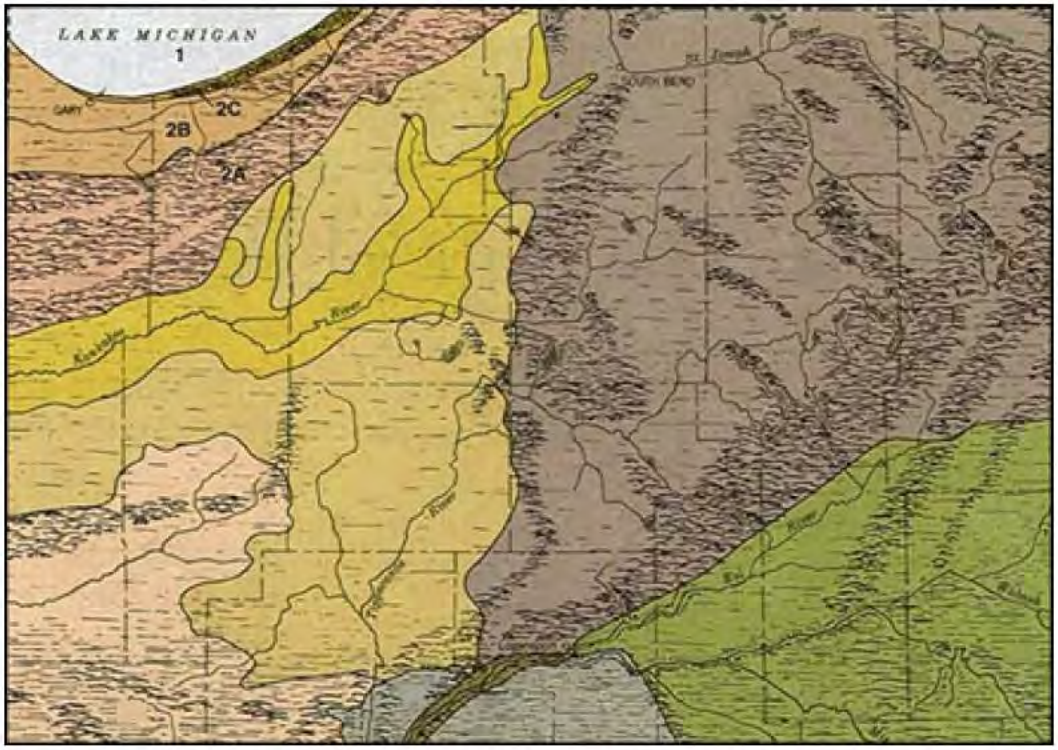
The physiography of the foredune complex is most directly influenced by natural erosion, sediment deposition, and winds produced by Lake Michigan (IDNR 2011). Three plant communities (beach, foredune, and blowout) are found within the foredune complex in the project area.

Beach Community. The beach plant community at Indiana Dunes National Lakeshore constitutes a narrow band that extends from the swash zone, the zone of wave action on the beach, to the farthest reach of storm waves. This area is also demarcated by the edge of Lake Michigan and the first line of dunes (Homoya 1985). It is influenced by wave action and shoreline dynamics and therefore, is constantly in flux. Plant species begin to colonize in the area just outside the influence of the swash zone and normal wave action. Characteristic beach plants are well adapted to the relatively harsh environmental conditions of the shoreline. American sea rocket (*Cakile edentula*) is the "vanguard of beach vegetation" (Swink and Wilhelm 1994) and today serves as one of the primary indicators of this distinct plant community. Other characteristic pioneer species of the beach plant community include American beachgrass or marram grass (*Ammophila breviligulata*), field wormwood (*Artemisia campestris* ssp. *caudata*), American bugseed (*Corispermum americanum*), and winged pigweed (*Cycloloma atriplicifolium*) (Homoya 1985; Swink and Wilhelm 1994). In addition to these beach colonizers, populations of silverweed cinquefoil (*Argentina anserine*) (an Indiana threatened species), seaside spurge (*Chamaesyce polygonifolia*)(an Indiana rare species), and beach pea (*Lathyrus japonicus* var. *maritimus*) (an Indiana endangered species) are rarely seen along the beach anymore.

Foredune Community. Foredunes are relatively small and sublinear in structure. If conditions allow, foredunes develop at the upper edge of the beach community and represent the first line of landward dune development (Wilhelm 1990). The foredune community in the project area is ranked as globally vulnerable (G3) and critically imperiled (G1) in the State of Indiana (IDNR 2011).

Foredune development is currently most active within the accretion zones in the project area along the Indiana shoreline, especially near Miller and West Beach. Foredunes generally increase in size moving from west to east (Wilhelm 1990). The foredune community intergrades with the beach community but is somewhat more stable than the latter due to the presence of established vegetation (Homoya 1985).

PITCHERS THISTLE



Legend

1. Lake Michigan Natural Region

2. Northwestern Morainal Natural Region
   - A. Valparaiso Moraine Section
   - B. Chicago Lake Plain Section
   - C. Lake Michigan Border Section

MAP 3-1
MAP OF THE NATURAL REGIONS OF INDIANA CROPPED TO SHOW NORTHWEST INDIANA

Indiana Dunes National Lakeshore
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National Park Service / U.S. Department of the Interior

March 2012

Source: Hoyoma et al. 1997

American beachgrass is the primary colonizer of these embryonic dunes, and effectively stabilizes and traps windblown sediment. Other key foredune indicator species include but are not limited to the following: bearberry (*Arctostaphylos uva-ursi*), field wormwood, prairie sand reed (*Calamovilfa longifolia* var. *magna*), red-osier dogwood (*Cornus sericea*), Canada wild rye (*Elymus canadensis*), common juniper (*Juniperus communis* var. *depressa*), beach pea, jack pine (*Pinus banksiana*) (state rare), eastern cottonwood (*Populus deltoides*), fragrant sumac (*Rhus aromatica* var. *arenaria*) (state rare), heartleaf willow (*Salix cordata*) (state threatened), little bluestem (*Schizachyrium scoparium*), and Deam's goldenrod (*Solidago simplex* var. *gillmanii*) (state threatened) (Homoya 1985; Wilhelm 1990). Although now largely confined to blowouts, Pitcher's thistle (*Cirsium pitcheri*) historically occupied foredunes (FWS 2002). The number of species of conservation concern that are representative of the foredune plant community are an indication of the rarity of this plant community in the project area.

Blowouts. Blowouts found within the foredune complex are formed by wind action or some other disturbance mechanism. Species found within the beach-foredune complex, including blowouts, depend on a "dynamic microhabitat for their persistence in the dune flora" (FWS 2002). Stabilized foredunes in the project area are dominated by perennials (such as American beachgrass) and often contain at least some tree or shrub species. Conversely, the early successional stages of blowouts have an affinity towards annual, biennial, and short-lived perennial species (Wilhelm 1990). Hence, the short-lived Pitcher's thistle, which lives up to approximately seven years and dies shortly after flowering (FWS 2002), is found within this community. Other vascular plant species common in blowouts include lyrate rockcress or sand cress (*Arabis lyrata*), common milkweed (*Asclepias syriaca*), prairie sand reed, American bugseed, Canada wild rye, flowering spurge (*Euphorbia corollata*), little bluestem, and purple sand grass (*Triplasis purpurea*) (Wilhelm 1990). As blowouts stabilize, the vegetation within them becomes dominated by more long-lived perennial species including bearberry, American bittersweet (*Celastrus scandens*), seaside spurge, red-osier dogwood, common juniper, eastern cottonwood, sand cherry (*Prunus pumila*), heartleaf willow, eastern poison ivy (*Toxicodendron radicans*), and riverbank grape (*Vitis riparia*). The blowout communities thus begin to become indistinguishable from the foredune community (Wilhelm 1990). The largest concentration of blowouts along southern Lake Michigan is located within Indiana Dunes National Lakeshore. See Figure 3-1: Sensitive Habitats, for general locations of blowout communities.

Dune Complex

The dune complex includes a successionally advanced stage of foredunes that consists primarily of savanna and forest (Homoya 1985; Wilhelm 1990). Plant communities present within the dune complex include later successional foredunes, savanna, and small pockets of mesophytic forest; however, the primary components of the dune complex are the stabilized dune forest community and the lee side dune forest (Wilhelm 1990). The high dunes of Indiana are often irregular dune ridges produced by prevailing northerly winds. High dunes in the Mount Baldy vicinity of the project area tend towards mesic habitat dominated by northern red oak (*Quercus rubra*) and white oak (*Quercus alba*). Black oak (*Quercus velutina*) becomes more dominant as one moves west along the shoreline, especially near the Miller and West Beach units in the project area.

Stabilized Dune Forest. The stabilized dune forest community in the project area is located leeward of the foredune complex and is slightly more mesic (due to the greater availability of moisture) than the very similar leeside dune forest community (Wilhelm 1990). This community and the leeside dune forest community are often difficult to

differentiate from the savanna and foredune communities with which they intergrade (Wilhelm 1990). Characteristic plant species in the stabilized dune forest community include red maple (*Acer rubrum*), American columbine (*Aquilegia canadensis*), roundleaf harebell (*Campanula rotundifolia*), flowering dogwood (*Cornus florida*), roundleaf dogwood (*Cornus rugosa*), eastern white pine (*Pinus strobus*), hairy Solomon's seal (*Polygonatum pubescens*), common hop tree (*Ptelea trifoliata* var. *mollis*), and northern red oak (Wilhelm 1990). Historically, the dune complex has been dominated by black oak, white pine, and jack pine (Whitman 1997).

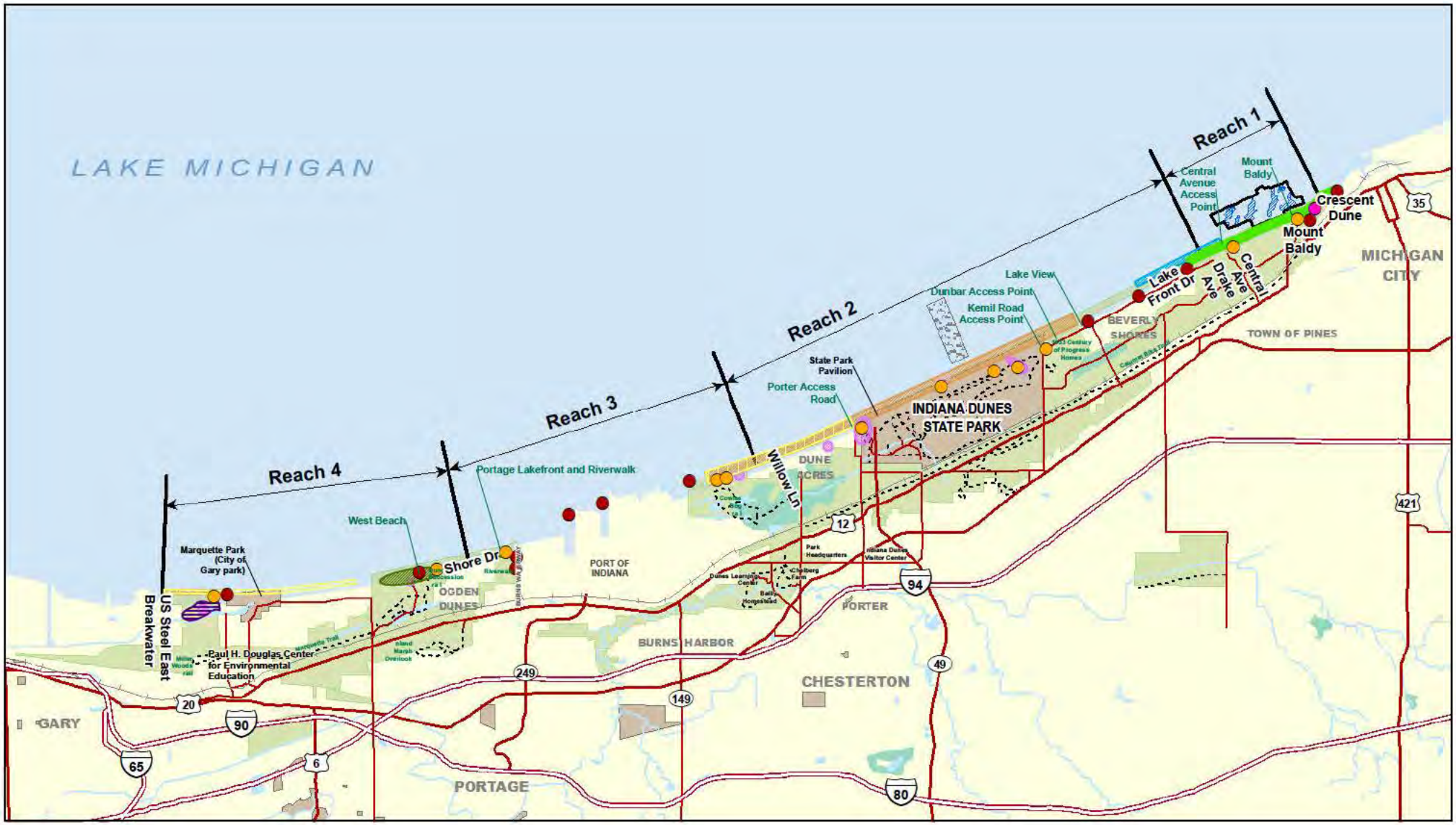
Leeside Dune Forest. The leeside dune forest community is similar to the stabilized dune forest community in the park but is not quite as mesic, and the two communities often intergrade. Vascular plants characteristic of the leeside dune forest include downy serviceberry (*Amelanchier arborea*), smooth yellow false foxglove (*Aureolaria flava*), autumn coralroot (*Corallorrhiza odontorhiza*), white ash (*Fraxinus americana*), hairy bedstraw (*Galium pilosum*), eastern teaberry (*Gaultheria procumbens*), Indian pipe (*Monotropa uniflora*), tall rattlesnake root (*Prenanthes altissima*), white oak, and showy goldenrod (*Solidago speciosa*) (Wilhelm 1990).

Mesophytic Forest. Pockets of mesophytic forest are rarely encountered within the dune complex at Indiana Dunes National Lakeshore and have likely arisen as a result of a lack of fire in this area. These moist pockets are characterized by sugar maple (*Acer saccharum*), bristleleaf sedge (*Carex eburnea*), white ash, American witchhazel (*Hamamelis virginiana*), eastern hop hornbeam (*Ostrya virginiana*), American ginseng (*Panax quinquefolius*), northern red oak, wreath goldenrod (*Solidago caesia*), American basswood (*Tilia americana*), and mapleleaf viburnum (*Viburnum acerifolium*) (Wilhelm 1990).

INVASIVE AND NONNATIVE PLANT COMMUNITIES

The National Park Service defines nonnative invasive plant species as "a species occurring in a given place as a result of direct or indirect, deliberate, or accidental actions by humans." More than 300 different species of nonnative plants have been documented at the park. Resource managers have to contend not only with current threats posed by invasive plant species, but also with emerging ones. The encroachment of nonnative species, particularly invasive plants, is a substantial problem that affects all habitats within the project area. The National Park Service has developed a prioritization plan to protect certain rare and ecologically sensitive units within the park, including pannes. Priority is currently given to newly detected species, small and more easily managed invasive plant populations, and highly invasive plant species (NPS 2011d).

Although numerous nonnative plant species are found throughout the project area, some possess a tremendous propensity to invade natural areas. Sand ryegrass (commonly referred to as lyme grass) (*Leymus arenarius*), yellow sweet clover (*Melilotus officinalis*), spotted knapweed (*Centaurea maculosa*), as well as several nonnative, invasive trees pose ecological threats to the beach and foredune plant communities. Common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*) and hybrid cattail (*Typha* x *glauca*) have already invaded numerous wetland areas, and pose the most substantial threat to pannes. Baby's breath (*Gypsophila paniculata*) is an emerging threat and invades open dune habitats, such as blowouts. Left unchecked, Baby's breath would easily displace Pitcher's thistle and other species of special concern.



Legend

- Blowouts
- Invasives Aquatics/Terrestrial
- Wetlands
- Foredune Restoration
- Active Foredune Development
- Interdunal Wetlands
- Pannes
- Fish Habitat
- Piping plover
- Pitcher's thistle
- Gravel, Muddy Gravel
- Yellow Perch Spawning Habitat
- Limits of Spawning Habitat

N

6,000 0 6,000

Feet

1 inch = 12,000 feet

Gravel Area Reference:
Foster, David S., and Folger, David W., 1994.
The Geologic Framework of Southern Lake Michigan.
Journal of Great Lakes Research, Volume 20.

FIGURE 3-1
SENSITIVE HABITATS
Indiana Dunes National Lakeshore
Shoreline Restoration and Management Plan / Environmental Impact Statement

National Park Service / U.S. Department of the Interior

March 2012

Garlic mustard (*Alliaria petiolata*) and nonnative bush honeysuckle (*Lonicera* sp.) easily invade the understory of the dune complex in the project area, and are found throughout reaches 1 through 4. Numerous invasive trees, such as tree of heaven (*Ailanthus altissima*), Siberian elm (*Ulmus pumila*), and black locust (*Robinia pseudoacacia*) are found throughout the foredune and dune complex in the project area. Oriental bittersweet (*Celastrus orbiculatus*), one of the most highly invasive vines found in the upper Midwest, is located throughout the dune complex. It has the propensity to invade open areas of the foredunes.

TERRESTRIAL INVERTEBRATES, BIRDS, AMPHIBIANS AND REPTILES, AND MAMMALS

Terrestrial Invertebrates

There are perhaps thousands of species of terrestrial invertebrates that have the potential to occur at the park. Many species of invertebrates that have the potential to occur are either unknown to science or poorly understood. Anecdotal evidence suggests that the park is home to many distinct species of invertebrates that reside in specific habitats. Tiger beetles (*Cicindela ocellata rectilatera*), for example, are as diverse as the habitats in which they reside. Some beetles are found solely in the mature dune forests, while others may only be found in the foredune complex in the park (Daniel 1984).

Birds

Lake Michigan and its nearshore offer both respite and important habitat for numerous resident and migratory bird species. Well over 300 different species of birds have been observed in the nearshore and dune complex at the park (Brock 2011). More than 100 species are regular nesters at the park, and 24 more species were formerly known to nest in the area. The habitat suitability and location of the park are critically important for migratory birds. As Brock (1997) stated, "The shores of this enormous lake provide leading lines that control flight paths of migrants, and the vast open water draws legions of transitory and wintering birds." Lake Michigan itself and the associated beach habitat provide two rare, albeit vital, habitats for avian species. The nearshore provides habitat for open water species (i.e., bay and sea ducks) and the beach and foredune complex provide resting and feeding habitat for shorebirds. In the fall, legions of migratory birds, including rare periodic migrants, are "funneled" to the park. The variation in habitats at the park provides many species of birds a place to rest during migration and provides habitats that are rare in the Midwest (Brock 1997).

Amphibians and Reptiles

The abundance and concentration of different types of habitat within the park make it an important area for amphibians and reptiles in the Midwest. Amphibians require water to breed and the park provides many wetland habitats such as pannes, marshes, bogs, swamps, streams, vernal pools, and ponds for different species to use. The wetland habitat at Indiana Dunes National Lakeshore provides for a high concentration of amphibian and reptile species to occur within the park, which is not typically observed in other regions.

The park has up to 49 different species of amphibians and reptiles: 19 species of amphibians (eight salamander and 11 frog species) and 30 species of reptiles (nine turtle, 18 snake, and three lizard species) (Minton 2001). Even though there is a diverse group of amphibians and reptiles at the park, many populations are declining in number. This is in large part due to habitat degradation, environmental pollution, wetland loss, and hydro-modification of stream systems.

Mammals

Most mammal species move across many habitats during their daily and seasonal activities and likely use many of the unique habitats that occur at the park. Some small mammal species are specific to certain habitats and the juxtaposition of prairie, wetland, forest, and urban/disturbed habitats creates opportunities for many small mammals to occur within the park. Furthermore, with an abundance of small mammal species, predator populations that prey on small mammals can be maintained in the park ecosystem.

Thirty-seven species of mammals are known to occur at the park, with an additional five species not found but likely to occur. Nine mammal species have been extirpated from Indiana and from the park in the past 150 years: porcupine (*Erethizon dorsatum*), gray wolf (*Canis lupus*), red wolf (*Canis rufus*), black bear (*Ursus americanus*), fisher (*Martes pennant*), mountain lion (*Felis concolor*), lynx (*Lynx lynx*), elk (*Cervus elephus*), and bison (*Bos bison*). Some species have moved into the park area or have become more abundant in the last 150 years, such as coyote (*Canis latrans*) and raccoon (*Procyon lotor*). White-tailed deer (*Odocoileus virginianus*) were extirpated early from the park and later the rest of Indiana, but were reintroduced to Indiana in 1935 and are now prolific throughout the state (Whitaker 1994).

THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONCERN

The unique environment at the park provides a mosaic of habitats for terrestrial plants and wildlife in a relatively small area. The park is located between the eastern deciduous forest, tall grass prairie, and Lake Michigan, creating a variety of soils and landscape features caused by the juxtaposition of all of these larger natural regions (Homoya 1985). Plant and wildlife diversity benefit from the variety, juxtaposition, and concentration of habitats. Many animal species spend different life stages in different habitats. In addition, the microclimate of the park varies considerably due to the effects of Lake Michigan. As a result, species such as bearberry, boreal relic, and prickly pear cactus (a southwestern relic), and other disparate floral elements are able to flourish in proximity to each other.

Approximately 130 plant species of conservation concern in Indiana, one federally threatened plant species (Pitcher's thistle), and one federally endangered butterfly (Karner blue butterfly [*Lycaeides melissa samuelis*]), have been documented at the park (NPS 2011d). The Eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*), a candidate for federal listing, is documented at the park. The Indiana bat (*Myotis sodalis*), a federally endangered species, has been found at the Heron Rookery Unit of the park, but is unlikely to be found in or adjacent to the project area because the beach and dunes do not provide suitable habitat. Critical habitat for the piping plover, a federally endangered bird species, has been designated along the shoreline between the NIPSCO / park boundary at the Dune Acres / Cowles Bog Unit next to Kemil Road at Beverly Shores, including Indiana Dunes National Lakeshore; this critical habitat is currently not known to be utilized for nesting but has been used during migration. Figure 3-1: Sensitive Habitats, shows general locations of sensitive habitats in the park. Unfortunately, numerous species have been extirpated over the last century, and many others are now declining or listed as endangered, threatened, or rare (see Appendix D: Species Lists).

VASCULAR PLANTS

The park supports an unusually high concentration of biodiversity, and therefore supports many globally and state important plant species. The park ranks near the top for parks in plant diversity within NPS lands. Scientists have documented more than 1,130 native vascular plants at the park (Yatskievych 2011). The Indiana Department of Natural Resources (IDNR) (2011) reports that 30% of Indiana's listed rare, threatened, endangered, and special concern plant species are known to occur at the park. There are more than 10 state-listed species found within the foredune complex of the project area. Pannes in the project area are even more diverse, with more than 200 different vascular plant species, of which 17 are listed as state endangered (see Appendix D: Species Lists).

Pitcher's Thistle

Pitcher's thistle is federally threatened and is one of the few plants endemic to post-Wisconsin glacial episode Great Lakes sand dunes. Populations of Pitcher's thistle indicate healthy dune ecosystems. Pitcher's thistle typically grows on foredunes with sparse vegetation. Six populations are located within the Indiana Dunes National Lakeshore (see Figure 3-1: Sensitive Habitats). The loss of foredune populations is largely attributable to the disruption of natural shoreline erosion processes and anthropogenic influences. Historically, populations were probably maintained in part by seed dispersal from adjacent foredune and blowout populations. The age at which Pitcher's thistle reproduces varies with environmental conditions, including drought, but generally ranges from five to eight years, although 10 to 12 years have been recorded (FWS 2005). Therefore,

disturbance and foredune erosion must be frequent enough to prevent succession and species loss, but not so frequent as to limit juveniles from reaching maturity (FWS 2002). Such a disturbance regime refers to a dynamically stable foredune complex (such as that witnessed in reaches 2 and 4 of the project area).

In Indiana, Pitcher's thistle colonizes in several of the blowouts in the project area. In these systems, seed dispersal from remaining blowout refugia (isolated or relict populations) would not disperse quickly to all dune habitats due to the distance between suitable habitats. Blowouts that lose self-sustaining populations are less likely to be re-colonized than areas in the more intact, continuous dune complexes. Instead, dune building relies on natural shoreline processes that increase sediment supply. The physical structure of foredunes is an important consideration in determining the habitat suitability and restoration of the Pitcher's thistle. Plants require approximately 70% open sand for successful seedling establishment and survival (FWS 2002). Populations of Pitcher's thistle would be further compromised in the park if blowouts undergo natural succession into another plant community, increasing total plant cover of open sediment. In addition, remaining thistle populations would be further impacted by human trampling and other anthropogenic influences.

TERRESTRIAL INVERTEBRATES

Karner Blue Butterfly

The Karner blue butterfly was historically found in 12 states from Minnesota to Maine but is now only found in seven states, including Indiana. The populations at the park are relatively small and are most threatened by habitat degradation and fragmentation. Wild lupine, or sundial lupine (*Lupinus perennis* L.), is the butterfly's only source of larval food. Isolated lupine populations are found in the dune complex. The reproduction of the butterfly depends on the abundance of lupine and nectar plant species. The park has a variety of savanna and savanna-like habitat in the dune complex, providing butterfly preferred habitat. The adults feed on the nectar of a variety of wildflowers and can be found in both wetlands and uplands at the park (FWS 2003b).

A population of Karner blue butterflies at West Beach is within the project area, and the Miller Woods population is adjacent to the project area, but the remaining populations are further inland and not included within the project area.

KARNER BLUE BUTTERFLIES

BIRDS

Piping Plover

Piping plovers are federally endangered. They breed and raise their young on sparsely vegetated beaches, cobble pans, and sand spits of glacially formed sand dune ecosystems along the Great Lakes shoreline. In similar context to Pitcher's thistle, piping plovers serve as an indicator of a healthy beach and foredune complex. Unfortunately, beach and foredune degradation is pervasive throughout the Great Lakes basins, and has reduced overall habitat suitability for many shoreline birds, including piping plovers. Human disturbances and contaminants, in addition to the genetic and geographic consequences of small population size, pose additional threats.

Historical nesting has occurred at the park, but no breeding populations have recently been documented (FWS 2003a) even though segments of the shoreline demonstrate physical characteristics suitable for piping plover breeding (see Figure 3-1: Sensitive Habitats). Critical habitat for the piping plover has been designated along the shoreline between the NIPSCO / park boundary at the Dune Acres / Cowles Bog Unit next to Kemil Road at Beverly Shores.

While transient individuals have been observed within the project area on an annual basis, anthropogenic influences, such as recreational beach activity at the park, may discourage re-establishment of breeding piping plover populations (FWS 2003a).

Bald Eagle

The bald eagle has been delisted under the Endangered Species Act, but the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act continue to afford the bird protection. The Bald and Golden Eagle Protection Act, passed in 1940, provides for the protection of the bald eagle and the golden eagle (*Aquila chrysaetos*) by prohibiting the take, possession, sale, purchase, barter, offer to sell, purchase or barter, transport, and export or import of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb. The Migratory Bird Treaty Act is a federal law that carries out the U.S.'s commitment to four international conventions with Canada, Japan, Mexico, and Russia. Those conventions protect birds that migrate across international borders. The Migratory Bird Treaty Act prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests except as authorized under a permit (FWS 2005).

Bald eagles currently do not nest at the park, but the population in Indiana and other Great Lakes states has been increasing, so they could nest in the park area in the future, since suitable habitat is available.

AMPHIBIANS AND REPTILES

Eastern Massasuaga Rattlesnake (*Sistrurus catenatus catenatus*)

The Eastern massasuaga rattlesnake is now a candidate for federal threatened or endangered listing. Historically, the massasuaga rattlesnake was found from central New York to eastern Iowa, and from southern Ontario to southern Illinois and Missouri (Minton 2001). In the past, the elusive rattlesnake was found at the park in greater numbers but may have become rare due to habitat degradation. The massasuaga rattlesnake prefers a variety of wetlands but can be found in upland habitats if prey species become scarce or thermoregulatory requirements must be satisfied. The massasuaga rattlesnake is found in high quality wetlands in the spring and fall, and may move to more upland sites in the summer. In the winter, they hibernate in small mammal burrows, crayfish holes, vegetation hummocks, or tree root masses near the water table (Glowacki 2005). Individuals have been observed within suitable habitats inland from the project area, although sightings are rare.

MAMMALS

Indiana Bat

The Indiana bat is federally listed as an endangered species mostly due to loss of habitat. This bat species ranges over most the eastern U.S. from New England, excluding much of the Atlantic Coast, to the Mississippi Valley, including most of the Midwest (FWS 2007a). During hibernation, Indiana bats form large groups of thousands of individuals. In the spring, females migrate to summer maternity colonies in dead or dying trees with exfoliating bark while males migrate to bachelor colonies. During the summer residency, the females give birth to their

young and raise them until they are able to fly. In the fall the newly volant young (able to fly) and adults migrate back to hibernacula or hibernation areas where mating takes place during fall swarming (Whitaker 1998). Roosting activities have been observed around dead cottonwood trees with loose peeling bark. Deciduous forest edges also provide viable habitat for foraging activities (Whitaker 1994). Habitat loss and urbanization are largely responsible for population declines throughout the region (Sparks 2005). Indiana bats have been found within the Heron Rookery Unit of the park but not within the project area, where suitable habitat is unlikely to be present.

WETLANDS AND PANNES

There are two wetland features specific to the park and the project area. These include the aquatic and panne communities. The aquatic areas include a wetland plant community which is exposed to water year-round. The plants are largely submersed, or the plants have stems topped by leaves and flowering parts extending to the water surface. The substrate may be sandy, gravelly, or mucky. The pannes are intradunal wetlands found in proximity to the shoreline, usually just behind the first or second set of dunes (Homoya 1985). Pannes are seasonally inundated areas where the substrate may be sandy or may comprise marl formed by an accumulation of calcium carbonate produced by the alga stonewort (*Chara* spp.) when inundated for long periods of time. Further discussion follows.

AQUATIC COMMUNITIES

The aquatic community tends to be wet most or all of the year and grades into the slightly drier marsh community. Common vascular plants found in the aquatic community in the Indiana Dunes National Lakeshore project area include: watershield (*Brasenia schreberi*), coontail (*Ceratophyllum demersum*), yellow pond lily (*Nuphar lutea* ssp. *advena*), American white water lily (*Nymphaea odorata* ssp. *tuberosa*), colored swampweed (*Polygonum amphibium* var. *emersum*), pickerel weed (*Pontederia cordata*), grassy pondweed (*Potamogeton gramineus*), Illinois pondweed (*Potamogeton illinoensis*), small pondweed (*Potamogeton pusillus*), and common arrowhead (*Sagittaria latifolia*) (Wilhelm 1990).

PANNES

Pannes are distinct calcareous, sand-based, intradunal wetlands found close to the shoreline, usually just behind the first or second set of dunes as one moves away from Lake Michigan (Homoya 1985). Naturally occurring pannes are extremely rare in the Great Lakes region, and are considered globally imperiled and critically imperiled in the State of Indiana. In addition, pannes are nutrient poor, with vegetation suggestive of a fen (Homoya 1985). Rhizomatous sedges such as smooth sawgrass (*Cladium mariscoides*) provide the dominant cover type (Chicago Wilderness 1999). There is a total of 20 pannes located within the project area. The largest concentration of naturally occurring pannes is located within reach 4 at West Beach. One isolated panne is located just east of Mount Baldy.

Despite their rarity and relatively small size, pannes demonstrate comparatively high floristic quality and diversity. Many of the plant species found within the panne community are found nowhere else in Indiana (Wilhelm 1990), and are considered relicts of the Atlantic coastal plain (Swink and Wilhelm 1994). Many of the species found in the pannes are of conservation concern because of this distribution. In addition to smooth sawgrass, pannes' characteristic plant species in the project area include golden sedge (*Carex aurea*), elk sedge (*C. garberi*), green sedge (*C. viridula*), shrubby cinquefoil

WEST BEACH PANNE

(*Dasiphora floribunda*), fringed gentian (*Gentianopsis crinita*), Kalm's St. Johnswort (*Hypericum kalmianum*), Baltic rush (*Juncus balticus* var. *littoralis*), yellow wide-lip orchid (*Liparis loeselii*), brook lobelia (*Lobelia kalmii*), horned beakrush (*Rhynchospora capillacea*), rosepink (*Sabatia angularis*), low nutrush (*Scleria verticillata*), prairie goldenrod (*Solidago ptarmicoides*), seaside arrowgrass (*Triglochin maritumum*), and horned bladderwort (*Utricularia cornuta*) (Homoya 1985; Swink and Wilhelm 1994; Wilhelm 1990). Some pannes, such as those within reach 4, are characteristically surrounded by jack pine. The deeper water zones within pannes are often dominated by algae species in the genus *Chara*.

SOUNDSCAPE

The soundscape of the shoreline and dunes area of the park includes both human and natural components. The latter consists of the sounds of the wind, sediment blowing against vegetation and waves, and sounds created by birds, insects, and other animals. The human component is generated by voices, pets, vehicles, boats, airplanes, recreational vehicles, and those sounds associated with activities at the park visitor's facility, nearby residential areas, and industrial operations. Transportation corridors, including the interstate highways near Indiana Dunes National Lakeshore and the Northern Indiana Commuter Transportation District (the South Shore Railroad), present soundscape intrusions from vehicle and track sounds and train whistles.

The park is bordered on the east and west by Michigan City and Gary, respectively, and it surrounds the industrial operations of the Port of Indiana and NIPSCO (which emit a rhythmic mechanical, industrial sound). In addition, there are three communities within the boundaries of the park: Town of Ogden Dunes, Town of Dune Acres, and Beverly Shores. At Beverly Shores, Lakefront Drive runs parallel to the beach and carries both park and local residential traffic.

Private cars, light trucks, and motorcycles, the type of vehicles that are most likely to use Lakefront Drive and other park-area beach and dune roads, emit noise levels ranging from 65 to 75 A-weighted decibels (dB[A]) at 7.5 meters. Similarly, noise levels for recreational boats with underwater exhausts typically range from approximately 75 to 85 dBA measured at a 50-foot bypass. However, depending on engine size and design (above or below water exhaust), recreational boat sound can be much higher. 2011 was the third consecutive year for the Super Boat Grand Prix sponsored by Michigan City, which is a high-speed offshore boat race. A high speed boat can produce sounds up to 170 dBA.

The sound environment of the park and project area changes seasonally. The project area experiences heaviest use in the summer season with commensurate levels of human and animal sound. While there may be more forceful wave and wind-related sound in the winter and fewer animal sounds, there are also fewer visitors to generate and experience sounds.

People perceive sound subjectively and may seek areas within the park and along the shoreline where they can experience the "natural quiet" (i.e., areas with little anthropogenic influence). Other people may prefer to enjoy the park near the more congested visitor's facilities, where human-generated sounds dominate.

In the project area, human-generated sounds dominate areas around: Mount Baldy and Central Avenue access point in reach 1; Lake View, Dunbar access point, Kemil Road access point, Porter access road, and State Park pavilion in reach 2; Portage Lakefront and Riverwalk in reach 3; and West Beach and Marquette Park in reach 4. In these areas, due to the high concentration of visitors, human-generated sounds dominate with human and vehicle sounds intruding into the natural soundscape. Figure 3-2: Visitor Access Points and Areas of Concentrated Use depicts areas within the project area with average high concentrations of park visitors. Other areas of the lakeshore provide natural quiet. Natural quiet can be experienced within areas of reaches 2, 3, and 4, where there are low concentrations of visitors.

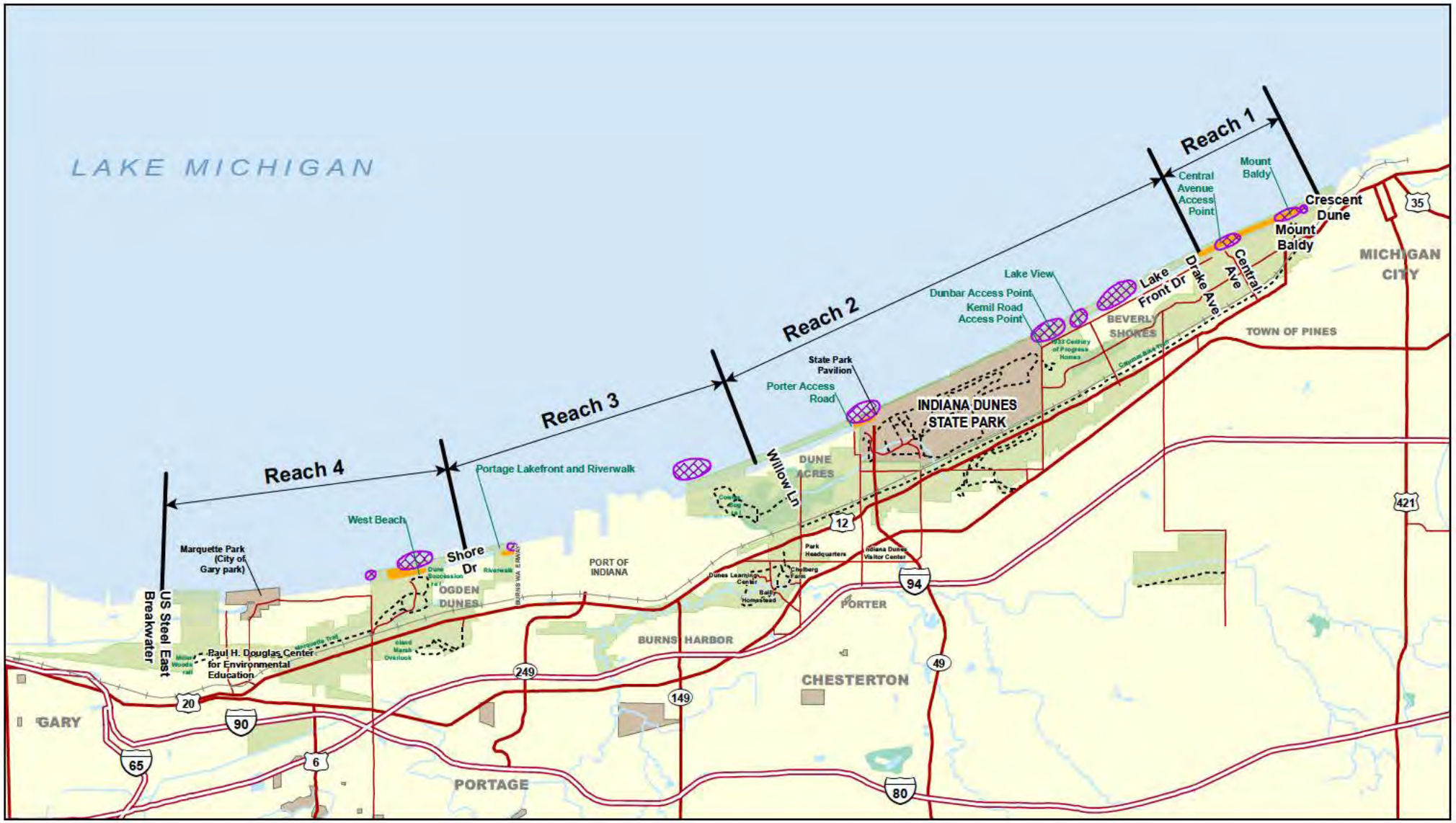
VISITOR EXPERIENCE

About two million people visit Indiana Dunes National Lakeshore each year, making it the most-visited outdoor recreation area in the region.

Visitor opportunities at Indiana Dunes National Lakeshore include hiking the dune trails; enjoying scenic views along the Lake Michigan shoreline, including the view across Lake Michigan of the Chicago skyline; enjoying the Lake Michigan beach and water access; swimming; using nonmotorized water craft; experiencing quiet, solitude, and naturalness; learning about the natural and cultural heritage of the area (e.g., glacial phenomena, diverse habitats, and human history); and understanding the complex natural history of the ecosystems that have evolved along the southern Lake Michigan shoreline.

Visitors tend to congregate at access points in the park that are interspersed along the lakefront. These include Mount Baldy, Central Avenue access point, Lake View picnic area, Dunbar access point, Kemil and Porter access points, and West Beach. See Figure 3-2: Visitor Access Points and Areas of Concentrated Use for locations of these areas. Access points and other areas of the park that experience a high concentration of visitors have more apparent and extensive anthropogenic influences, like vegetation trampling and introductions of nonnative and invasive weeds. Such influences have to be monitored and managed by the park to prevent destruction and degradation of natural resources.

In addition, there are a number of interpretive learning centers throughout the park, though not within the project area. Park staff participate in ongoing planning activities to improve visitor's experience while balancing the potential impacts to the natural environment.



Legend

Access Points with a High Concentration of Visitors

Visitor Impact Area

N

6,000 0 6,000 Feet

1 inch = 12,000 feet

FIGURE 3-2
VISITOR ACCESS POINTS AND AREAS OF CONCENTRATED USE

Indiana Dunes National Lakeshore
Shoreline Restoration and Management
Plan / Environmental Impact Statement

National Park Service / U.S. Department of the Interior
March 2012

PARK OPERATIONS

Management of the park is organized from the superintendent's office into five functional divisions, including Interpretation and Education, Resource and Visitor Protection, Facility Management, Resource Management, and Administration (Business Services). The superintendent is responsible for overall park management. In addition to responsibilities for overall leadership and coordination of the park, staff are responsible for public and external affairs, planning and compliance, and safety, all of which relate to the actions proposed under all the action alternatives in this plan / final EIS. Shoreline erosion and associated restoration efforts result in greater personnel demands for resource protection.

The Interpretation and Education Division includes education services for diverse audiences. This division is responsible for visitor education and outreach in the park, and providing opportunities for visitors to connect with park resources and to learn how to protect park resources. Interpretive rangers provide educational information to the public and become more actively involved with the public depending on the level of public interest. Due to the duration of beach closings that would be associated with each of the action alternatives presented in this plan / final EIS, public interest is anticipated to be high and would require additional park staff and budget to provide the public with ongoing updates and interpretive programs during the life of this plan.

The Resource and Visitor Protection Division of the park is responsible for visitor and employee safety and resource protection, as well as visitor education. This division oversees beach closings during nourishment activities to ensure both visitor and employee safety. Division staff would have increased responsibilities related to safety and resource protection during the additional beach nourishment activities proposed under this plan, placing additional burdens on the park's operating budget.

The Facility Management Division maintains the park, performing routine upkeep of facilities, structures, and landscapes, including the park's shoreline and forested dunes. Ongoing erosion and degradation of the shoreline and dunes taxes park staff and budgets with added responsibilities related to resource protection and restoration activities.

The Resources Management Division of the park is responsible for natural resource inventory and monitoring, managing natural resources research, protecting threatened and endangered species and species of concern, restoring disturbed sites, managing invasive nonnative species, and protecting and preserving cultural resources including historic structures, cultural landscapes, archeological resources, ethnographic resources, and museum objects. Park resources are actively monitored and managed during beach nourishment activities and would continue to be with any of the additional nourishment activities proposed under any of the action alternatives presented in this plan / final EIS. Increasing the duration or frequency of such activities through the beach nourishment activities proposed under this plan would incrementally add to park staff workloads and place additional drains on park budgets.